CLAIMS

1. An efficient telecommunications receiver system for accurately decoding a received composite signal having data signal and pilot signal components comprising:

first means for receiving said composite signal and extracting a pilot signal and a data signal therefrom;

second means for calculating a log-likelihood ratio as a function of a channel estimate based on said pilot signal; and

third means for scaling said log-likelihood ratio by a predetermined log-likelihood ratio scaling factor and providing an accurate log-likelihood value in response thereto; and

fourth means for decoding said received composite signal based on said accurate log-likelihood value and said data signal.

2. The system of Claim 1 wherein said pilot signal and said data signal comprise pilot samples and data samples, respectively.

3. The system of Claim 2 wherein said third means includes a carrier signal-to-interference ratio circuit for computing a first signal-to-interference ratio and a second signal-to-interference ratio based partly on said pilot signal.

4. The system of Claim 3 wherein said first signal-to-interference ratio is based on said data samples, and said second signal-to-interference ratio is based on said pilot samples, said first signal-to-noise ratio and said second signal-to-noise ratio providing input to a circuit for computing said scaling factor included in said third means.

5. The system of Claim 1 wherein said first means includes a despreader for despreading said received composite signal in accordance with a predetermined spreading function and providing a despread signal in response thereto.

6. The system of Claim 5 wherein said spreading function is a pseudo noise sequence or a Walsh function.

7. The system of Claim 5 wherein said first means further includes a decovering circuit for extracting said pilot signal and said data signal from said despread signal.

8. The system of Claim 1 wherein said third means includes means for calculating a primary carrier signal-to-interference ratio based on said pilot signal and said data signal.

9. The system of Claim 8 wherein said third means includes a data noise variance estimation circuit for computing a noise variance of said data signal based on said data signal and an energy signal derived from said data signal.

10. The system of Claim 9 wherein said data noise variance estimation circuit includes means for computing said noise variance of said data signal in accordance with the following equation:

$$\sigma_z^2 = \frac{-2|\alpha(n)|^2 + \sqrt{4|\alpha(n)|^4 - 3\left[\frac{3\sum_N |x^2(n)|^2}{N - \left|\overline{x^2(n)}\right|^2}\right]}}{3} \approx \frac{\sqrt{7|\alpha(n)|^4 - \frac{3\sum_N |x^2(n)|^2}{N}} - 2|\alpha(n)|^2}{3},$$

where σ_z^2 is said noise varaince of said data signal; $|\alpha(n)|^2$ is an absolute value of said energy signal; $x^2(n)$ is said energy signal; n is a discreet time variable; and N is a number of data samples over which said noise variance of said data signal is computed.

11. The system of Claim 9 wherein said third means includes a divider circuit for computing said primary carrier signal-to-interference ratio as a function of an absolute value of said energy signal and said noise variance of said data signal.

12. The system of Claim 11 further including a data sample signal-to-noise ratio circuit and a channel estimate signal-to-noise ratio circuit for computing a first signal-to-interference ratio and a second signal-to-interference ratio, respectively, based on said primary signal-to-noise ratio.

13. The system of Claim 12 wherein said third means computes said log-likelihood ratio scaling factor in accordance with the following equation:

$$k = \frac{2}{\left(1 + \gamma_d / \gamma_{\hat{\alpha}} + 1 / \gamma_{\hat{\alpha}}\right)},$$

where k is said log-likelihood ratio scaling factor; γ_d is said first signal-to-interference ratio; and $\gamma_{\hat{\alpha}}$ is said second signal-to-interference ratio.

14. The system of Claim 13 wherein said first signal-to-interference ratio γ_d is described by the following equation:

$$\gamma_d = \frac{\overline{E}_s}{\sigma_s^2},$$

where $\overline{E}_s$ is an average energy of said pilot signal, and σ_s^2 is a noise variance of said received composite signal.

15. The system of Claim 13 wherein said second signal-to-interference ratio $\gamma_{\hat{\alpha}}$ is described by the following equation:

$$\gamma_{\hat{\alpha}} = \frac{\overline{E}_s}{\sigma_{\hat{\alpha}}^2},$$

where $\overline{E}_s$ is an average energy of said pilot signal, and $\sigma_{\hat{\alpha}}^2$ is a noise variance of said pilot signal at an output of a lowpass filter.

16. The system of Claim 1 wherein said second means includes a lowpass filter for filtering said pilot signal and providing a filtered pilot signal in response thereto as a channel estimate.

17. The system of Claim 16 wherein said second means includes a first multiplier for selectively multiplying said data signal by a complex conjugate of said channel estimate and providing a weighted signal in response thereto.

18. The system of Claim 17 wherein said second means includes a scaling circuit for scaling a real part of said weighted signal by a predetermined constant factor and yielding a preliminary log-likelihood ratio in response thereto.

19. The system of Claim 18 wherein said third means includes a second multiplier for multiplying said preliminary log-likelihood ratio by said predetermined scale factor and providing said accurate log-likelihood value in response thereto.

20. The system of Claim 1 wherein said second means includes a filter for providing a filtered pilot signal having a reduced interference component and a complex conjugate circuit for providing a complex conjugate of said filtered pilot signal as output.

21. The system of Claim 20 wherein said third means includes a means for multiplying said complex conjugate by said data signal to yield a result, said result scaled by a predetermined constant factor to yield a rough log-likelihood ratio in response thereto corresponding to said rough log-likelihood ratio further scaled by said predetermined log-likelihood ratio scaling factor of said third means to yield said accurate log-likelihood value.

22. The system of Claim 1 further including an optimal path combining circuit for optimally combining said data signal and said pilot signal in accordance with an estimate of an interference component of said composite received signal and providing an optimally combined signal to said third means in response thereto.

23. The system of Claim 22 wherein said third means includes a scaling circuit for multiplying said optimally combined signal by said predetermined log-likelihood ratio scaling factor to yield said accurate log-likelihood value.

24. The system of Claim 23 wherein said optimal path combining circuit includes means for providing said estimate of said interference component, said means for providing including a lowpass filter for filtering said pilot signal to provide a filtered pilot signal.

25. The system of Claim 24 wherein said means for providing said estimate further includes a subtractor for subtracting said filtered pilot signal from said pilot signal and providing said estimate of said interference component in response thereto.

26. The system of Claim 1 wherein said third means includes a carrier signal-to-interference ratio computation circuit for computing a primary carrier signal-to-interference ratio.

27. The system of Claim 26 wherein said carrier signal-to-interference ratio computation circuit includes means for estimating an interference component of said received composite signal.

28. The system of Claim 27 wherein said means for estimating an interference component includes a lowpass filter for filtering said pilot signal to provide a filtered pilot signal; a received signal energy computation circuit for providing a value representative of a total energy of said received composite signal; and a means for combining said pilot signal and said value to yield said primary carrier signal-to-interference ratio.

29. The system of Claim 28 wherein said second means includes data sample signal-to-interference ratio circuit and a channel estimate carrier signal-to-interference ratio circuit for generating said first signal-to-interference ratio

and said second signal-to-interference ratio, respectively, based on predetermined scaling factors.

30. The system of Claim 26 wherein said carrier signal-to-interference ratio computation circuit includes a first section for receiving said composite signal; said composite signal having a desired signal component and an interference and/or noise component; a signal extracting circuit for extracting an estimate of said desired signal component from said received signal; and a noise estimation circuit for providing an accurate noise and/or interference value based on said estimate of said desired signal component and said composite signal.

31. The system of Claim 30 wherein said carrier signal-to-interference ratio computation circuit further includes means for employing said accurate interference energy value to compute said primary carrier signal-to-interference ratio.

32. The system of Claim 31 further including means for computing optimal path combining weights for multiple signal paths comprising said signal using said accurate noise and/or interference value and providing optimally combined signal paths in response thereto to said third means, said third means for computing said log-likelihood ratio based on said carrier signal-to-interference ratio and said optimally combined signal paths.

33. The system of Claim 32 wherein said fourth means further includes a turbo decoder for decoding said received signal using said log-likelihood value.

34. The system of Claim 33 further including means for generating a rate and/or power control message and transmitting said rate and/or power control message to an external transceiver in communication with said efficient receiver system.

35. A system for determining a log-likelihood ratio for a communications system receiver employing turbo codes and pilot assisted demodulation comprising:

means for determining a log-likelihood value and

means for scaling said log-likelihood value by a predetermined factor to account for error in an estimate of a channel based on a pilot signal and providing said log-likelihood ratio to said communications system receiver employing turbo codes.

36. A system for calculating a log-likelihood ratio for a receiver employing pilot assisted coherent demodulation comprising:

a first receiver section for decovering a turbo-encoded signal having a pilot signal component and a data signal component, said turbo-encoded signal received over a channel;

a channel detection circuit for obtaining an estimate of said channel based on said received pilot signal component;

a log-likelihood ratio calculation circuit for providing a log-likelihood ratio based on said channel estimate and its noise variance, and said received data signal component and its noise variance; and

a second receiver section for employing said log-likelihood ratio to decode said data signal component.